NOTE TO: Don Cool/IMNS — November 30, 1999

FROM: Tony Huffert/DWM [initials]

SUBJECT: RESPONSE TO QUESTIONS ON TWO ITEMS IN THE 11/16/99 COMMISSION MEMORANDUM ENTITLED, "METALS RECYCLING AT BNFL, INC."

In a memorandum dated November 16, 199, Dennis Rathbun (Office of Congressional Affairs) forwarded a fact sheet developed by BNFL, Inc. regarding the disposition of the Oak Ridge material by Manufacturing Sciences Corporation (MSC). Following receipt of the fact sheet by the Commission, questions arose about information contained in the last two bullets of the fact sheet. The following is the staff's response to the questions:

Question 1: Is the exposure a child would receive from wearing orthondotic braces containing nickel released by MSC 13,000 times less than the exposure they would receive from the x-rays required to prepare the braces?

Answer 1: The comparison in the BNFL fact sheet is based on information contained in MSC's December 8, 1998, license amendment request to conduct decontamination and unrestricted release operations of DOE volumetric contaminated nickel. The request includes a supporting risk analysis of the proposed nickel releases, which includes dose estimates from orthodontic braces (0.001 mrem per year) and x-rays for orthodontic brace preparation (40 mrem per year). BNFL used MSC's dose estimates and assumed that a child would wear the braces for 3 years. Given these assumptions, BNFL concluded the x-ray exposure would be about 13,000 times greater than wearing the braces ((40 mrem/yr)/(0.001 mrem/yr x 3 years) = 13,333). A copy of Table 4.2 from the MSC risk analysis is attached for reference.

It is recognized that dose estimates of dental x-rays depend on a number of assumptions, such as the type of procedure, film speed, screen sensitivity, x-ray technique used, as well as the total number of x-ray views taken for an orthodontic preparation. In Table 4.2 of their risk analysis, MSC cited NCRP Report No. 93 (1987), entitled "Ionizing Radiation Exposure of the Population of the United States," as the basis for their dose estimate of 40 mrem/yr for orthodontic brace preparation. The staff could not identify the 40 mrem/yr dose value from NCRP 93. The only value of about 40 mrem/yr in the report appears in Table 7.4. The discussion for the basis of Table 7.4 indicates that doses from dental x-ray examinations were not included in this table because dental examinations are "estimated to contribute less than 0.01 mSv (1mrem) to the total average annual effective dose equivalent." A copy of pages 46 and 47 of NCRP 93 are attached for reference.

Another point of reference is information the staff obtained from a review of the RADSAFE listserver archives on the subject of dental x-ray exposures. According to information published in a 1992 report, the effective dose from a single panoramic x-ray would range from 0.4 to 1.5 mrem. In comparison, a full mouth intraoral exam would range from 3 to 15 mrem.

Based on the above information, the staff does not agree with the BNFL statement that dental x-rays would produce more than 13,000 times the dose estimated by MSC for a child wearing orthodontic braces with contaminated nickel. Although it is difficult to establish a comparison based on the variability in dose estimates from dental x-ray examinations and the uncertainty in MSC's dose estimate from a child wearing orthodontic braces with contaminated nickel, it is likely there is far less difference in dose than BNFL stated in their fact sheet.

Question 2. Does the staff have a copy of the two reports - one by the National Academy of Sciences and the other by Lockheed Martin Environmental Services - that are referred to in the last bullet of the fact sheet?

Answer 2. The staff has a copy of the National Academy of Sciences report that is referred to in the fact sheet. It is entitled "Affordable Cleanup? Opportunities for Cost Reduction in the Decontamination and Decommissioning of the Nation's Uranium Enrichment Facilities" (1996).

The staff is obtaining copies of two Lockheed Martin Reports, entitled "Initial Operations Analysis and Plans for the Oak Ridge K-25 Site Large Scale Metals Recycle Project" (February 1996) and "Concepts for Decontamination and Decommissioning of U.S. Gaseous Diffusion Plants through Beneficial Reuse of Materials and Equipment" (August 1996).

NCRP REPORT No. 93

IONIZING RADIATION EXPOSURE OF THE POPULATION OF THE UNITED STATES

NCRP

National Council on Radiation Protection and Measurements examinations are calculated from tables of absorbed doses to organs (Rosenstein, 1976) and the ICRP weighting factors. For the examinations denominated as "Other" (including thoracic spine, full spine, mammography, etc.), the H_E was estimated from the mean value of the specified procedures. The greatest contributors to the collective effective dose equivalent are lumbar spine, upper gastrointestinal and barium enema examinations; these three procedures provide more than 50 percent of the total collective effective dose equivalent. Dental examinations have been omitted since they are estimated to contribute less than 0.01 mSv (1 mrem) to the total average annual effective dose equivalent (see Wall and Kendall, 1983).

The collective effective dose equivalents from nuclear medical procedures are given in Table 7.3. The numbers of tests performed annually are from Mettler *et al.* (1985). The greatest contributors to the collective effective dose equivalent are bone, cardiovascular and brain examinations which contribute about 60 percent of the total effective dose equivalent.

Effective dose equivalents from diagnostic medical exposures are summarized in Table 7.4 (NCRP, 1987f). Dose equivalents to the gonads and the bone marrow are given in Table 7.5 (NCRP, 1987f). The GSDs derived from the gonad doses have been estimated for diagnostic x rays to be 40 to 100 μSv (4 to 10 mrem) for males and 180 to 200 μSv (18 to 20 mrem) for females, totalling 220 to 300 μSv

TABLE 7.3—*Collective effective dose equivalent from diagnostic nuclear medicine tests in the U.S. in 1982*

Examination	Annual number of examinations (thousands)	Average effective dose equivalent per examination (μSv)[b]	Average annual collective effective dose equivalent[a] (person-Sv)[c]
Brain	810	6,500	5,300
Hepatobiliary	180	3,700	700
Liver	1,400	2,400	3,400
Bone	1,800	4,400	8,000
Lung	1,200	1,500	1,800
Thyroid	680	5,900	4,000
Kidney	240	3,100	700
Tumor	120	12,000	1,500
Cardiovascular	950	7,100	6,700
Rounded total	7,400	4,300	32,000

[a] Number obtained from product of previous two columns but using unrounded figures.
[b] 1 μSv = 0.1 mrem.
[c] 1 person-Sv = 100 person-rem.

NCRP No. 93

(22 to 30 mrem). For nuclear medicine, the GSD has been estimated to be about 20 μSv (2 mrem) (NCRP, 1987f).

As would be expected, the greatest contributors to the genetically significant dose are diagnostic x-ray examinations. During the decade 1970–1980, the GSD has increased, reflecting an increase in the total number of x-ray examinations (Table 7.6). The recorded annual GSD of 220 to 300 μSv (22 to 30 mrem) is probably an overestimate because

TABLE 7.4—*Annual effective dose equivalents from all medical examinations in the U.S.*

Modality	Annual collective effective dose equivalent (person-Sv)[a]	Average annual effective dose equivalent in the U.S. population (μSv)[b]
Diagnostic x-rays (1980)	91,000	390
Nuclear medicine (1982)	32,000	140
	123,000	530

[a] 1 person-Sv = 100 person-rem.
[b] 1 μSv = 0.1 mrem.

TABLE 7.5—*Annual dose equivalent to gonads and bone marrow from medical examinations in the U.S.*

Modality and target tissue	Annual collective dose equivalent (person-Sv)[a]	Average annual dose equivalent (μSv)[b]
Diagnostic x-rays		
Gonads	50,000–70,000	–
Bone marrow	160,000–250,000	750–1,100
Nuclear medicine		
Gonads	4,400	–
Bone marrow	32,000	140

[a] 1 person-Sv = 100 person-rem.
[b] 1 μSv = 0.1 mrem.

TABLE 7.6—*Estimated total diagnostic medical and dental x-ray procedures in the United States*

	Number of examinations (in thousands)		
	1964	1970	1980
Medical	109,000	136,000	180,000
Dental	54,000	67,000	101,000
Total	163,000	203,000	281,000
	Frequency per 1,000 population		
Frequency	870	990	1,240

Risk Analysis:

Nickel Contaminated with ^{99}Tc and Uranium

November, 1998

Prepared for:
Manufacturing Sciences Corporation
804 Kerr Hollow Road
Oak Ridge, TN 37830

Prepared by:
Auxier & Associates, Inc.
10317 Technology Drive, Suite 1
Knoxville, Tennessee 37932

MSC / Auxier & Associates

Table 4-2 Dose Comparisons

Whole Body Equivalent	mrem/yr	Source
Average Natural Background Radiation	300	a
Hip Joint Prosthesis	0.0014	b
X-Ray for Hip Joint Prosthesis Implant	130	a
Orthodontic Braces	0.001	b
X-Ray for Orthodontic Braces Preparation	40	a
Glaze on False Teeth (Full Denture)	2	c, d
Nickel Alloy Eyeglass Frames	0.001	b
Thorium Containing Flux on Eyeglasses	0.4	c
Flatware	0.00022	b
Glazed Ceramic Tableware (Glaze Containing Uranium)	~1	c, d

[a] NCRP93. 1987.
[b] Calculated in this Report
[c] NCRP95. 1987.
[d] Older Products - No Longer Available Commercially

4.1 Flatware

Exposures from the radionuclides present in stainless steel flatware containing MSC's reprocessed nickel were assumed to occur when the utensils were held in a human hand. The mixture of ^{99}Tc and uranium (plus prompt daughters) produces alpha, beta, and gamma radiation. Alpha radiation has a short range and would be blocked by the dead layer of skin on the hand or on any other part of the body. Doses from the beta radiation component were calculated using the computer code VARSKIN (Durham, 1998). The results are presented in Table 4.3. Gamma doses were calculated using the MicroShield computer code from Grove Engineering (Grove, 1995). Results from the MicroShield calculations are presented in Table 4.4.

RADSAFE Archive Search Results

Your query was:
dental panoramic x-rays

Re: dental x-ray web informati "Gibbs, S Julian" Mon, 30 Mar 1998 13:33:46 +1000 (Sy

From: "Gibbs, S Julian"
Subject: Re: dental x-ray web information
Date: Mon, 30 Mar 1998 13:33:46 +1000 (Sydney Standard Time)

Effective doses (or effective dose equivalents) from dental x-ray procedures have been derived from (1) organ doses measured in RANDO phantoms from exposure by dental x-ray beams, chiefly at University of Texas at San Antonio; and (2) Monte Carlo calculations of organ doses, chiefly in my laboratory. The best review is by Stuart White, Dentomaxillofacial Radiol 21:118-126, 1992. There has been little of consequence added since 1992. Stu has concluded that effective doses for full-mouth intraoral exams (14-22 films) range from 30 to 150 uSv and for panoramic exams from 4 to 15 uSv. Most authors have compared these doses to effective doses from all environmental exposure, including particulates in the lungs, to avoid the apple/orange problem. Full-mouth intraoral exams done with state-of-the-art technology (E-speed film, rectangular collimation, etc.) then deliver doses equivalent to about 1 day of environmental exposure. For techniques in common clinical use (D-speed film, 7-cm round beams) in the US, the dose is equivalent to about 1 week of environmental exposure. We now know how to reduce dental dose significantly below that in common clinical practice. This is like anything else: it takes years to transfer technology from lab to clinic.

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and Decommissioning
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Board on Energy and Environmental Systems
Commission on Engineering and Technical Systems
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K/ER-300

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ENVIRONMENTAL RESTORATION PROGRAM

Initial
Operations Analyses and Plans for the Oak Ridge K-25 Site Large Scale Metals Recycle Project

Date Issued - February 23, 1996

Lockheed Martin Energy Systems, Inc.
P.O. Box 2003
Oak Ridge, Tennessee 37831-7294

managing contractor
for the
U.S. Department of Energy
under contract DE-AC05-84OR21400

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UCN-17560

K-25

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K/ER-300, rev. 1

Concept for Decontamination and Decommissioning of U.S. Gaseous Diffusion Plants Through Beneficial Reuse of Materials and Equipment

Date Issued - August, 1996

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